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# Analysis of aggressive behaviours of pigs by automatic video recordings

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ABSTRACT

Aggression among pigs in today's production systems results in negative impact on health and welfare of animals as well as on productivity of the systems. Precision Livestock Farming technology might potentially offer a possibility to monitor and reduce the level of aggression and hence its negative impact. This paper reports about the initial part of a larger study investigating the possibilities of applying continuous automatic monitoring of aggressive behaviour among pigs. It investigates how behavioural patterns in pig's aggressive behaviour can be identified and utilized in order to predict severe forms of aggression (biting) expressed in later phases of aggressive interactions.

An experiment was carried out at a commercial farm on a group of 11 male pigs weighing on average 23 kg and kept in a pen of 4 m × 2.5 m. During the first 3 days after mixing in total 8 h of video recording were registered with a top view camera for later analysis of animal behaviour. As a result of labelling of the video recordings, 157 aggressive interactions were identified with 12 behaviour types expressed for 860 times within the interactions. The identified interactions were divided into interactions that led to biting and those that did not lead to biting behaviour. The interactions that led to biting behaviour accounted for 36.3% (57) of all aggressive interactions while interactions that did not lead to biting behaviour were 63.7% (100) of the interactions. The average duration of initiating (nosing) phase of aggressive interactions (3.32 s) lasted longer ($P < 0.05$) in interactions that led to biting behaviour than in interactions that did not lead to biting behaviour (1.94 s). The next phase of aggressive interactions – medium phase – similarly to initiating phase, lasted on average longer (18.21 s) ($P < 0.01$) in interactions that led to biting behaviour than in interactions that did not lead to biting behaviour (16.15 s). With the differences found between interactions that led and did not lead to biting behaviour it seems to be possible to discriminate between both types of interactions in an early phase of aggression. The differences found might serve as early signs in a management support system that aims to prevent severe forms of aggressive behaviour (biting) among pigs.



## 1. Introduction

The social organization of domesticated pigs, *sus scrofa*, living under farm conditions is, as in wild pigs, based upon a dominance hierarchy (McBride et al., 1964). Hierarchy develops as a part of pig's social life and is a form of group organization. Establishment of social hierarchy results in division of a group of pigs to subgroups of dominants, subdominants, submissive, subordinate and marginal. Two types of dominance hierarchy can develop in a group of pigs: a linear order or a triangle type (Hafez, 1975). In the latter case individual pigs differ less in social position.

If piglets originating from at least two different litters are weaned into one pen then hierarchical order is formed. The practice can result in intense aggression which continues mainly throughout the first 24–48 h after a new group of animals is composed, thus when the dominance hierarchy is being established (Marchant-Forde, 2010). A new hierarchical order develops always when a composition of a group of pig's changes, therefore for example when pigs are mixed during transfer to the older age groups (Keeling and Gonyou, 2001).

Conditions in confined environment can cause dominance hierarchy to be less successful in controlling aggression within the group, increasing the incidence of aggressive behaviour throughout pig's group life (Ewbank and Bryant, 1969). The conditions

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are: limited space allowance (Jensen, 1984), competition for feed (Walker, 1995), barren environment (Durrell et al., 1997), low fibre feed composition, (Meunier-Salaun et al., 2001).

An elevated aggression level has negative impact on health, welfare (McGlone et al., 1981; Marchant-Forde, 2010) and productivity of pigs (Stookey and Gonyou, 1994; Arey and Edwards, 1998). The idea of reducing aggression level among pigs in confinement was investigated by many researchers. The following methods were tested: application of sedatives (Tan and Shackleton, 1990), odour masking agents (Barnett et al., 1993), provision of environmental enrichment (Melotti et al., 2011; Waran and Broom, 1993; McGlone and Curtis, 1985; Schaefer et al., 1990), increase of space allowance (Gonyou et al., 2006), change of dry feeding system to wet (Andersen et al., 1999), increase amount of fibre in sow's diet (Meunier-Salaun et al., 2001).

Possibilities of Precision Livestock Farming technology in relation to the problem of aggression have not been explored yet and might offer a new possibility to effectively lower aggression level among pigs. Precision Livestock Farming (PLF) is defined as the management of livestock production using the principles and technology of process engineering. PLF relies upon automatic monitoring of livestock and related physical processes (Wathes et al., 2008). PLF is currently regarded as the heart of the engineering endeavour towards sustainability in (primary) food production. Its application allows making optimal use of knowledge and information in the monitoring of processes (Berckmans, 2008).

This paper aims to be an initial step in creating an automatic monitoring system of pigs aggression. The focus of the article is to perform human eye observation and analysis in a way that the results could be used in the next steps for development of the automatic system.

The basic studies on pig aggressive behaviour performed by McGlone (1985) revealed that it is a complex and gradual behaviour. The fight breaks out gradually as the pigs investigate each other using a series of specific and often reciprocal behaviours, characterized by nosing, sniffing and gentle nudging. This may then escalate into more vigorous pushing, pressing, bites and head-knocking, out of which biting is considered to be the most damaging (Turner et al., 2006). Thus, as the fight progresses, the intensity increases which means that more damaging behaviours occur more frequently later in the fight. The last phase of aggressive interactions consists of direct sampling of actual fighting ability, through overt, dangerous fighting (Jensen and Yngvesson, 1998). Therefore our hypothesis is that identification of patterns in sequences of specific behaviours and understanding the gradual development of aggressive behaviour should allow automated monitoring and prediction of aggressive behaviour expressed in the final phase of these interactions. In order to monitor these behaviours with an automatic monitoring system we defined the following objectives for this study:

- Identification of differences between aggressive interactions leading to biting behaviour and those that do not lead to this behaviour.
- Identification of early signs of biting behaviour on the basis of behavioural patterns occurring within aggressive interactions, before biting behaviour.

## 2. Materials and methods

### 2.1. Animals and housing

In order to achieve the objectives of the study behavioural observations were carried out. The observations were carried out at a commercial farm, located in Heusden, the Netherlands, with a capacity of approximately 6000 fattening pigs (Topigs 20 (large White × Landrace) × Pietrain) weighing from 23 to 120 kg. Eleven non-castrated male pigs, weighing 23 kg on average were observed in a pen sized 4 m × 2.5 m. The pen was surrounded by solid, plastic wall. A floor of the pen was constructed from concrete. Half of the pens floor was slatted while the other half was solid, barren surface. The pigs used in the experiment were originating from 4 different pens (3 + 3 + 3 + 2 pigs) and were mixed immediately before the observation started. The pigs were fed *ad libitum* with a dry feeding system at one feeder with two feeding places. The feeder was located in the front part of the pen, near the corridor of a compartment from where the observations were performed. A source of drinking water in form of a metal drinker was installed on the feeder's wall. Air exchange was provided by a mechanical, central flow ventilation system. A source of light in the compartment was two windows (each 1 × 1 m) and six 100 Watt fluorescent tubes. In time of observations artificial lighting was turned on. Natural and artificial lighting provided illuminance of 50 lux in the observed pen. Pigs were individually marked by standard colour stock marker spray on their backs in order to identify individuals on the video recordings.

### 2.2. Experimental installations

The video recordings were registered using a camera (Allied Vision Technologies®, model F080C) with 4.8 mm lens, placed above the pen in central position at a height of 2.3 m, that permitted a top view of the whole pen. Colour images were captured with a frame rate of 11 frames per second and a resolution of 1032 × 778 pixels. The videos were stored in a computer for later analysis. A total of 8 h of video recordings were registered in this way during the first 3 days after mixing (day 1: 2 h, day 2: 3 h, day 3: 3 h). In the first day of the observations the recordings were registered from 11.00 to 13.00 o'clock, on the second and third day from 11.00 to 14.00 o'clock. The reason for shorter period of observation on the first day of the trial was technical problems experienced on the farm.

### 2.3. Labelling procedure

Video recordings registered by the camera during the experiment were labelled by human observer according to a video labelling procedure. The procedure consisted of a labeller watching the video recordings and noting his observations. Interactions were observed on the video images frame by frame to determine the exact starting frame and time and duration of the aggression and to describe the pig's behaviour within aggressive interactions. Recordings were captured at a frame rate of 11 frames per second, which translates to 316,800 frames in 8 h of video material (1 min = 60 s, 1 h = 3600 s, 8 h = 28,800 s and 28,800 s × 11 frames = 316800 frames). It took approximately 90 men hours to label 8 h (316,800 frames) of video recordings. It was only possible to label the behaviours on the video recordings with a precision of 1 s. Behaviour in order to be classified by the labeller as a behavioural event had to be performed by animals for at least 1 s (Jensen and Yngvesson, 1998).

Behaviours chosen to be labelled in video labelling procedure were: nose to nose interaction, head to head knocking, head to body knocking, inverse parallel pressing, parallel pressing, neck biting, body biting, ear chewing, jump on other, aiming, chasing and walking, as reported in Table 1.

Within behaviours listed above head to head knocking, head to body knocking, inverse parallel pressing, parallel pressing, aiming, neck biting, body biting and chasing were categorized as aggressive behaviours. Nose to nose and ear chewing behaviours were categorized as interaction behaviours, jump on other as sexual behaviour, walking as locomotion behaviour (Table 1). Behaviour